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METHOD AND APPARATUS OF RECORDING A HIGH DEFINITION DIGITAL TELEVISION BROADCAST SIGNAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and apparatus of recording a high definition digital television (HDTV) broadcast signal to a high-density disk storage medium such as a HD-DVD (High-Density Digital Versatile Disk).

2. Description of the Related Art

A conventional analog television signal is transmitted through air or cable after AM or FM modulation.

In these days, digital technologies related with video compression and modulation/demodulation has been remarkably advanced, so that digital television broadcast, whose standard is locally under discussion, is being introduced in air broadcasting system. The digital television broadcast system has

adopted MPEG standard as video and audio compression method.

The digital broadcast system can provide higher quality than analog system, transmit several different programs through an allocated single band, and make it possible to fully use resources and media for digital communication and storage.

In digital broadcasting system, several programs whose data are encoded to MPEG are multiplexed and then delivered in the format of TS (Transport Stream) to a receiving terminal such as a STB (Set Top Box). The receiving terminal extracts the TS carrying a selected program from received data and decodes the extracted TS into original audio and video signal which are applied to a displaying apparatus such as a television set.

Fig. 1 depicts a digital broadcast receiving system schematically. This system consists of a STB 100, a streamer 200, IEEE 1394 communication line, and a conventional television set 300. In the STB 100, a receiving unit 11 receives digital television broadcast signal, which includes encoded several programs, and extracts TS carrying a desirable program selected by a controller 14 according to user's command. The extracted TS is decoded into video and audio signal by a TS decoder 12 and then outputted to a television set 300. Otherwise, the extracted TS is delivered to the streamer 200 through IEEE 1394 interfaces 13 and 21 to record the selected program to a disk storage medium 23.

The STB 100 can also receive TS-formatted program recorded in the disk storage medium 23 from the streamer 200 through the

IEEE 1394 interfaces 13 and 21, and decode the received TS to video and audio signal through the TS decoder 12. The decoded video and audio signal are outputted to the television set 300.

In the meantime, a high-density DVD (Digital Versatile Disk) is being developed to record high-quality moving pictures of high definition grade since a digital television set being able to present an HDTV signal is being commercialized. The storage capacity target of a high-density DVD is about 15 Gbytes which is 3.2 times of about 4.7 Gbytes of a conventional DVD. It is possible to record in a high-density DVD about 135 minute-long moving picture data of high definition grade.

Therefore, a standard for recording an HDTV signal broadcasted from a broadcasting station to a writable high-density DVD through a STB and a streamer as aforementioned is under discussion among related companies.

However, a provisional standard for a streamer specifies that acceptable maximum input bit rate is about 11.0 Mbps whereas the data bit rate of moving pictures of high definition grade has a range of 19.26 ~ 23Mbps. As a result, a streamer observing the provisional standard can not record high definition moving pictures broadcasted from a broadcasting station to a disk recording medium normally. Therefore, a new recording method for an HDTV signal is needed.

In addition, if an HDTV signal is widely used in the near future, there will be great need of receiving HDTV program directly without an intermediary STB and recording it.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide method and apparatus for receiving an HDTV signal without an intermediary apparatus, and recording the received signal to a writable high-density recording medium in an appropriate writing format or transmitting the received signal to an external apparatus connected through a digital interface such as IEEE 1394 standard.

An apparatus of recording an HDTV signal according to the present invention, comprises a demodulator demodulating a received HDTV signal into data streams of individual channels; a data processor extracting data stream of a channel chosen among the individual channels and converting the extracted data stream to transport stream; a stream analyzer analyzing data of the transport stream, and extracting and creating data stream- and/or recording-related information; and a writing means writing information from said stream analyzer and the transport stream from said data processor to a recording medium in a format suitable to the extracted and created information.

A method of recording an HDTV signal according to the present invention, demodulates a received HDTV signal, extracts transport stream belonging to a chosen channel among the demodulated data stream, analyzes data of the transport stream, extracts and creates data stream- and/or recording-related information, and writes the data stream- and/or recording-related information and the transport stream to a recording

medium in a format suitable to the extracted and created information.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate the preferred embodiments of the invention, and together with the description, serve to explain the principles of the present invention.

In the drawings:

Fig. 1 depicts a digital television signal receiving system schematically;

Fig. 2 shows an example of home appliance network;

FIG. 3 is a block diagram of a high-density DVD recorder being able to record an HDTV signal according to the present invention;

Fig. 4 depicts data format of a TP (Transport Packet) forming transport stream of a digital television broadcast signal; and

Figs. 5 and 6 are examples of data stream recorded according to the present invention.

DETAILED DESCRIPTION OF THE PREFFERRED EMBODIMENT

In order that the invention may be fully understood, a preferred embodiment thereof will now be described with reference to the accompanying drawings.

Fig. 2 shows an example of home appliance network. In network of Fig. 2, a high-density DVD recorder 400 records a received HDTV broadcast signal to a writable high-density DVD or transmits the received HDTV signal to a digital television 500 being able to accept data stream of HDTV signal or a STB 600 which is connected through IEEE 1394 standard. The data stream of HDTV signal may be received from a digital broadcasting station or a high definition digital video camera connected through IEEE 1394.

The high-density DVD recorder 400 may have an MPEG decoder decoding digital data stream to analog video and audio signal which is for a high definition monitor 700 not equipping with a MPEG decoder.

The internal components of the high-density DVD recorder 400 and their operations are explained in detail hereinafter.

FIG. 3 is a block diagram of the high-density DVD recorder 400 comprising a VSB demodulator 41 receiving an HDTV signal and demodulating it into individual channel data with VSB method; a parsing and de-scrambling unit 42 extracting data stream of a chosen channel and de-scrambling the extracted data stream into TS (Transport Stream); a stream analyzer 43 de-packetizing the TS into series of 188 byte-long TPs (Transport Packets), and extracting and analyzing necessary information for recording presentation and navigation data; a bit engine 45 reconstructing A/V presentation data of the TS into bit stream whose format is suitable to writing; a controller 44 extracting navigation data

contained for management and presentation control in the TS and controlling the recording operation according the extracted navigation data; a pickup 46 writing the extracted presentation and navigation data to a high-density DVD 47; and a digital interface 48 transmitting the TS to a STB 600 or a digital television 500 through IEEE 1394 standard.

An MPEG decoder 49, which can decode TP-formatted presentation data into respective analog video and audio signal, is optionally equipped in the high-density DVD recorder 400 to support a high definition monitor 700 not having an MPEG decoder in it.

In the high-density DVD recorder 400, the VSB demodulator 41 receives a VSB-modulated HDTV signal and demodulates it into individual channel data, and the parsing and de-scrambling unit 42 extracts data stream of a program selected by a user from the demodulated channel data, and de-scrambles the extracted data stream into TS consisting of TPs.

The stream analyzer 43 de-packetizes the TS into individual 188 byte-long TPs, extracts header data of each TP, and analyzes the extracted header data. The extracted header data and the analyzed results are delivered to the bit engine 45 and the controller 44 at the same time. The controller 44 determines the recording format of presentation and navigation data based on the received header data and analyzed results.

In the meantime, a TP consists of a header and payload field as shown in Fig. 4. A header field contains various

information for a packet, and a payload field contains substantial audio or video data to send and receive. A header includes a sync byte, a PID (Packet Identifier) indicative of type of data written in the payload field, RAI (Random Access Information) indicative of whether this packet is accessible in random, a PCR (Program Clock Reference) for clock information to refer in transmitting TPs, and a PTS (Presentation Time Stamp) for time information to refer in presenting a corresponding TP.

The stream analyzer 43 reads each header and interprets the aforementioned various information from data written in the header. The interpreted information is delivered to the bit engine 45 and the controller 44 at the same time, and it is used as information for determining the presentation and navigation data recording format of the high-density DVD 47. For example, presentation data are recorded such that it has time information on transmitting intervals based on the PTS written in each header, and the number of pictures per an unit of time, for example, 1 second, which is obtained from the data analysis, is written as navigation data.

Fig. 5 is an example of data stream recorded based on PTS information written in a packet header. For this exemplary recording, the stream analyzer 43 not only extracts PID, RAI, PCR, if any, and PTS and analyses them but also discriminates between video and audio packets, and sends the extracted data and the analyzed information such as position information of I-pictures (Infra-coded) and P-pictures (Predictive) to both of

the bit engine 45 and the controller 44.

The bit engine 45 records presentation data in a high-density stream object (called 'HOB' hereinafter) as shown in Fig. 5 using the data and information from the stream analyzer 43. The recorded HOB consists of a plurality of high-density stream object units (called 'HOBU's hereinafter), and each HOBU is written in several high-density packs. A high-density pack consists of a header and data field in which several TPs are written.

A RDI (Real-time Data Information), which is indicative of sector positions of I-pictures and/or P-pictures for random access during trick play, is written before transport stream in the first high-density pack of each HOBU. This RDI is acquired with reference to the analyzed information of the stream analyzer 43 and data stream recorded positions by the bit engine 45.

The extracted PTS and PCR by the stream analyzer 43 are also written in a header of a pack. A distance offset of the first TP from starting position of a pack is calculated by the bit engine 45 and then written in the header. The number of TPs is counted for a pack and is also written in the header.

The transport stream is recorded by the bit engine 45 such that an arbitrary HOBU begins from the starting data of a GOP (Group of Pictures), which includes at least one I-picture. Such writing alignment is accomplished with reference to presentation time relation between audio and video packets and whether or not

an I-picture is included in the current data stream. This referring information is also received from the stream analyzer 43.

In the meantime, the controller 44 calculates PTS time difference between start and end position of each HOBU based on PTS of each TP, which is received from the stream analyzer 43, as well as the size of that HOBU, and writes the calculated time difference and size information in a mapping list which is one of disk navigation data and is used for mainly searching operation.

Due to the method of recording the received data stream after analyzing it, it is possible to adapt the recording format to the received data stream.

Fig. 6 is an example of recorded data stream according to the above-explained aligning method between an arbitrary HOBU and GOP start.

For recording as in Fig. 6, if necessary, the stream analyzer 43 reconstructs discriminated video packets into MPEG-formatted stream, calculates the size of each GOP, the number of pictures in a GOP, and/or frame rate such as time per a picture based on the information written in an MPEG header of the reconstructed MPEG stream, and sends the calculated data to the bit engine 45 and the controller 44.

The bit engine 45 may write the received the number of GOPs and location information of each GOP, which is calculated based on the received size of each GOP, in the aforementioned RDI as

information to refer for random access, instead of the written information as RDI in the embodiment of Fig. 5.

The controller 44 calculates the number of pictures contained in each HOBU, which is grouped by the bit engine 45 while recording, and the size of each HOBU based on the received information from the stream analyzer 43, and writes the calculated data in each entry of the mapping list. Each entry is associated with each HOBU. The controller 44 also writes the received information on frame rate in the field of HOB General Information, which is for a collection of recorded HOBUs, that is, HOB.

The digital television broadcast signal recording method and apparatus according to the present invention, records a directly-received an HDTV broadcast signal without any intermediary signal receiving apparatus such as a set top box to a high-density recording medium in an appropriate recording format after analyzing the received signal, or transmits it to an external apparatus connected through a digital interface such as IEEE 1394. In addition, trick play for recorded HDTV broadcast signal can be smoothly conducted due to such recorded format and various written information which has been obtained from analysis of received data stream of HDTV signal.

The invention may be embodied in other specific forms without departing from the sprit or essential characteristics thereof. The present embodiments are Therefore to be considered in all respects as illustrative and not restrictive, the scope

of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are Therefore intended to be embraced therein.